E/E DIAGNOSTIC TEST MODES—SAE J1979 JUN94 SAE Recommended Practice

Report of the SAE Vehicle E/E Systems Diagnostic Standards Committee approved December 1991, and revised June 1994. Rationale statements available.

Foreword—This document describes the implementation of the Diagnostic Test Modes necessary to meet California On-Board Diagnostic (OBD II) and Federal On-Board Diagnostic (OBD) requirements for emission related test data. This document is one of several prepared by task forces of the SAE E/E Diagnostics Committee in order to satisfy the proposed regulations. The development of these recommended practices has been coordinated so that they are compatible with each other and with the legislation. Other documents necessary in addition to this document are:

SAE J1930—E/E Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms
SAE J1962—Diagnostic Connector
SAE J1978—OBD II Scan Tool
SAE J2012—Recommended Format and Messages for Diagnostic Trouble Codes

In addition, the diagnostic data communication link to be utilized with these recommended practices is specified by the regulation to be as specified in one of the following documents:

SAE J1850—Class B Data Communication Network Interface
ISO 9141-2:1994(E)—Road vehicles—Diagnostic systems—CARB requirements for interchange of digital information

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1. Scope—This SAE Recommended Practice defines diagnostic test modes, and request and response messages, necessary to be supported by vehicle manufacturers and test tools to meet the requirements of the California OBD II and Federal OBD regulations, which pertain to vehicle emission-related data only. These messages are intended to be used by any service tool capable of performing the mandated diagnostics.

Diagnostic Test Modes included in this document are:

a. Mode $01—Request Current Powertrain Diagnostic Data
   - Analog inputs and outputs
   - Digital inputs and outputs
   - System status information
   - Calculated values

b. Mode $02—Request Powertrain Freeze Frame Data
   - Analog Inputs and outputs
   - Digital inputs and outputs
   - System status information
   - Calculated values

c. Mode $03—Request Emission-Related Powertrain Diagnostic Trouble Codes

d. Mode $04—Clear/Reset Emission-Related Diagnostic Information

e. Mode $05—Request Oxygen Sensor Monitoring Test Results

(R) f. Mode $06—Request On-Board Monitoring Test Results for Non-Continuously Monitored Systems

(R) g. Mode $07—Request On-Board Monitoring Test Results for Continuously Monitored Systems

For each test mode, this specification includes:

a. Functional descriptions of test mode

b. Request and response message formats

(R) For some of the more complex test modes, an example of messages and an explanation of the interpretation of those messages is included.

2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1850—Class B Data Communication Network Interface

SAE J1930—E/E Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms

SAE J1962—Diagnostic Connector

SAE J1978—OBD II Scan Tool

SAE J2012—Recommended Format and Messages for Diagnostic Trouble Codes

SAE J2186—Diagnostic Data Link Security

SAE J2190—Enhanced E/E Diagnostic Test Modes

2.1.2 ISO DOCUMENTS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 9141-2:1994(E)—Road vehicles—Diagnostic systems—CARB requirements for interchange of digital information

2.1.3 CALIFORNIA ARB DOCUMENTS—Available from California Air Resources Board, 9528 Telstar Avenue, El Monte, CA 91731.

California Code of Regulations, Title 13, Section 1968.1—Malfunction and Diagnostic System Requirements—1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II)

(R) 2.1.4 FEDERAL EPA DOCUMENTS—Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Environmental Protection Agency 40 CFR Part 86—Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Regulations Requiring On-Board Diagnostic Systems on 1994 and Later Model Year Light-Duty Vehicles and Light-Duty Trucks

2.2 Definitions—Most terms for components and systems contained in this document are included in SAE J1930. This section includes additional definitions of terms not included in SAE J1930.

2.2.1 ABSOLUTE THROTTLE POSITION SENSOR—This value is intended to represent the throttle opening. For systems where the output is proportional to the input voltage, this value is the percent of maximum input signal. For systems where the output is inversely proportional to the input voltage, this value is 100% minus the percent of maximum input signal. Throttle position at idle will usually indicate greater than 0%, and throttle position at wide open throttle will usually indicate less than 100%.

2.2.2 BANK—The group of cylinders which feed an oxygen sensor. Bank 1 contains the Number 1 cylinder.

2.2.3 BASE FUEL SCHEDULE—The fuel calibration schedule programmed into the Powertrain Control Module or PROM when manufactured or when updated by some off-board source, prior to any learned on-board correction.

2.2.4 CALCULATED LOAD VALUE—An indication of the current airflow divided by peak airflow, where peak airflow is corrected for altitude, if available. Mass airflow and barometric pressure sensors are not required for this calculation. This definition provides a unitless number that is not engine specific, and provides the service technician with an indication of the percent engine capacity that is being used (with wide open throttle as 100%).

$$CLV = \frac{\text{Current airflow}}{\text{Peak airflow (@ sea level)}} \times \frac{\text{Atmospheric pressure (@ sea level)}}{\text{Barometric pressure}} \times 100\% \quad \text{(Eq.1)}$$

2.2.5 CONTINUOUS MONITORING—Sampling at a rate no less than two samples per second.

2.2.6 FUEL TRIM—Feedback adjustments to the base fuel schedule. Short-term fuel trim refers to dynamic or instantaneous adjustments. Long-term fuel trim refers to much more gradual adjustments to the fuel calibration schedule

than short-term trim adjustments. These long-term adjustments compensate for vehicle differences and gradual changes that occur over time.

3. Technical Requirements

3.1 Diagnostic Test Mode General Conditions—These guidelines are necessary to ensure proper operation of both the test equipment and the vehicle during diagnostic procedures. Test equipment, when using messages defined in this document, should not affect normal operation of the emission control system.

3.1.1 MULTIPLE RESPONSES TO A SINGLE DATA REQUEST—The messages contained in this document are functional messages, which means the off-board test equipment will request data without knowledge of which module on the vehicle will respond. In some vehicles, multiple modules may respond with the information requested. In addition, a single module may send multiple responses to a single request. Any test device requesting information must, therefore, have provisions for receiving multiple responses.

3.1.2 RESPONSE TIME—For SAE J1850 network interfaces, the on-board systems should respond to a request within 100 ms of a request or a previous response. With multiple responses possible from a single request, this allows as much time as is necessary for all modules to access the data link and transmit their response(s). If there is no response within this time period, the tool can either assume no response will be received, or if a response has already been received, that no more responses will be received.

For ISO 9141-2 interfaces, response time requirements are specified in the ISO 9141-2 document.

3.1.3 MINIMUM TIME BETWEEN REQUESTS FROM SCAN TOOL—For SAE J1850 network interfaces, a tool should always wait for a response from the previous request, or "no response" timeout before sending another request. In no case should a request be sent less than 100 ms after the previous request.

For ISO 9141-2 interfaces, required times between requests are specified in the ISO 9141-2 document.

3.1.4 DATA NOT AVAILABLE—There will be no reject message for a request for data if the data value is not supported by the module.

3.1.5 MAXIMUM VALUES—If the data value exceeds the maximum value possible to be sent, the on-board system should send the maximum value possible ($FF or $FFFF). The tool should display the maximum value or an indication of data too high. This is not normally critical for real time diagnostics, but in the case of a misfire at 260 km/h with resulting freeze frame data stored, this will be very valuable diagnostic information.

3.2 Diagnostic Message Format

3.2.1 ADDRESSING METHOD—Functional addressing will be used for all generic Diagnostic Test Mode messages because the test tool does not know which system on the vehicle has the information that is needed.

3.2.2 MAXIMUM MESSAGE LENGTH—SAE J1850 defines required message elements and maximum message lengths that effectively limit the number of bytes that can be defined by this document to 12 bytes.

3.2.3 DIAGNOSTIC MESSAGE FORMAT—To conform to the SAE J1850 limitation on message length, diagnostic messages specified in this document begin with a three byte header, have a maximum of 7 data bytes, require ERR (error detection byte), and allow RSP (in-frame response byte), as shown in Figure 1.

Header Bytes (Hex)			Data Bytes								
Priority /Type	Target Address	Source Address	#1	#2	#3	#4	#5	#6	#7	ERR	RSP
Diagnostic Request at 10.4 Kbps (J1850 and ISO 9141-2)											
68	6A	Fx	Maximum 7 data bytes							Yes	No
Diagnostic Response at 10.4 Kbps (J1850 and ISO 9141-2)											
48	6B	addr	Maximum 7 data bytes							Yes	No
Diagnostic Request at 41.6 Kbps (J1850)											
61	6A	Fx	Maximum 7 data bytes							Yes	Yes
Diagnostic Response at 41.6 Kbps (J1850)											
41	6B	addr	Maximum 7 data bytes							Yes	Yes

FIGURE 1—DIAGNOSTIC MESSAGE FORMAT

3.2.4 HEADER BYTES—The first three bytes of all diagnostic messages are the header bytes. The value of the first header byte is dependent on the bit rate of the data link and the type of message, as shown in 3.2.3. The second byte has a value that depends on the type of message, either a request or a response. The third header byte is the physical address of the device sending the message.

Device address $F1 should be used for an OBD II Scan Tool, or any other tool that does not have a special reason to use another address. Other service tools should use addresses in the range from $F0 to $FD. The response to all request messages in this document will be independent of the address of the test equipment requesting the information.

Vehicle manufacturers should not use the SAE J1979 header bytes for any purpose other than diagnostic messages. When they are used, they must conform to this specification.

3.2.5 DATA BYTES—The maximum number of data bytes available to be specified in this document is 7. The first data byte following the header is the test mode, and the remaining 6 bytes vary depending on the specific test mode. Each unique diagnostic message defined in this document is a fixed length, although not all messages are the same length. For modes $01 and $02, message length is determined by Parameter Identification (PID). For Mode $05, message length is determined by Test ID. For other modes, the message length is determined by the mode. This enables the tools to check for proper message length, and to recognize the end of the message without waiting for possible additional data bytes.

(R) 3.2.6 NON-DATA BYTES INCLUDED IN DIAGNOSTIC MESSAGES WITH SAE J1850—All diagnostic messages will use a Cyclic Redundancy Check (CRC), as defined in SAE J1850, as the error detection (ERR) byte.

In-frame response (RSP) is defined as optional in SAE J1850. For messages defined in this document, the RSP byte is required in all request and response messages at 41.6 Kbps, and is not allowed for messages at 10.4 Kbps.

SAE J1850 defines additional message elements that may be included in Diagnostic Messages. Use of these message elements is beyond the scope of this specification, but need to be considered when defining total diagnostic messages.

3.2.7 NON-DATA BYTES INCLUDED IN DIAGNOSTIC MESSAGES WITH ISO 9141-2—Messages will include a checksum, defined in ISO 9141-2, after the data bytes instead of the CRC used with SAE J1850.

There is no provision for an in-frame response in ISO 9141-2.

3.2.8 BIT POSITION CONVENTION—Some data byte values in this document include descriptions that are based on bit positions within the byte. The convention used in this document is that the Most Significant Bit (MSB) is referred to as "bit 7," and the Least Significant Bit (LSB) is referred to as "bit 0," as shown in Figure 2:

FIGURE 2—BIT POSITION WITHIN A DATA BYTE

(R) **3.3 Allowance for Expansion and Enhanced Diagnostic Test Modes**—This document allows for the addition of Diagnostic Test Modes both as industry standards and manufacturer specific modes. Enhanced Diagnostic Test Modes are defined in a separate SAE document, J2190. That document reserves functional test modes $00 through $0F to be defined in SAE J1979 if needed to accommodate future legislated requirements.

(R) **3.4 Format of Data to be Displayed**—The format of data to be displayed to the user of the data obtained with these test modes needs to be standardized so that vehicle manufacturers can write generic service information. The following table indicates the type of data and minimum requirements for format of the data. See Figure 3.

4. Test Modes

4.1 Mode $01—Request Current Powertrain Diagnostic Data

4.1.1 FUNCTIONAL DESCRIPTION—The purpose of this mode is to allow access to current emission related data values, including analog inputs and outputs, digital inputs and outputs, and system status information. The request for information includes a Parameter Identification (PID) value that indicates to the on-board system the specific information requested. PID definitions, scaling information, and display formats are included in this document.

The on-board module will respond to this message by transmitting the requested data value last determined by the system. All data values returned for sensor readings will be actual readings, not default or substitute values used by the system because of a fault with that sensor.

Data	Modes	Display Format
Device ID - source address of response	all	Hexadecimal (00 to FF)
Parameter ID (PID)	$01 & $02	Hexadecimal (00 to FF), description, or acronym (see table in Section 4.3)
Frame number	$02	Decimal (0 to 255)
Data values	$01 & $02	see table in Section 4.3
Diagnostic Trouble Codes	$03 & $07	"P" plus 4 digits and/or DTC definition - see SAE J2012
Test ID	$05 & $06	Hexadecimal (00 to FF)
Test value and test limits	$05	Engineering units for Test IDs less than $80 (see Section 4.6.2) - Decimal (0 to 255) for Test IDs greater than $80
Test value and test limits	$06	Decimal (0 to 65535)
Component ID	$06 (part of data byte #3)	Hexadecimal (00 to 7F)

(R) FIGURE 3—FORMAT OF DATA TO BE DISPLAYED

Not all PIDs are applicable or supported by all systems. PID $00 is a bit-encoded PID that indicates, for each module, which PIDs that module supports. PID $00 must be supported by all modules that respond to a Mode $01 request as defined in this document, because diagnostic tools that conform to SAE J1978 use the presence of a response by the vehicle to this request to determine which protocol is supported for OBD II communications.

4.1.2 MESSAGE DATA BYTES—(See Figure 4.)

	Data Bytes (Hex)						
	#1	#2	#3	#4	#5	#6	#7
Request Current Powertrain Diagnostic Data							
Request Powertrain Diagnostic Data	01	PID					
Report Current Powertrain Diagnostic Data							
Report Powertrain Diagnostic Data	41	PID	data A	data B (opt)	data C (opt)	data D (opt)	

FIGURE 4—MESSAGE DATA BYTES

4.2 Mode $02—Request Powertrain Freeze Frame Data

4.2.1 FUNCTIONAL DESCRIPTION—The purpose of this mode is to allow access to emission related data values which were stored during the freeze frame required by OBD regulations. This mode allows expansion to meet manufacturer specific requirements not necessarily related to the required freeze frame, and not necessarily containing the same data values as the required freeze frame. The request for information includes a Parameter Identification (PID) value that indicates to the on-board system the specific information requested. PID definitions, scaling information, and display formats for the required freeze frame are included in this document.

(R) The on-board module will respond to this message by transmitting the requested data value stored by the system. All data values returned for sensor readings will be actual readings, not default or substitute values used by the system because of a fault with that sensor.

Not all PIDs are applicable or supported by all systems. PID $00 is a bit-encoded PID that indicates, for each module, which PIDs that module supports. Therefore, PID $00 must be supported by all modules that respond to a Mode $02 request as defined in this document.

(R) PID $02 is the DTC that caused the freeze frame data to be stored. If freeze frame data is not stored in the module, the system should report $00 00 as the DTC. Any data reported when the stored DTC is $00 00 may not be valid.

The frame number byte will indicate $00 for the OBD II mandated freeze frame data. Manufacturers may optionally save additional freeze frames and use this mode to obtain that data by specifying the freeze frame number in the request. If a manufacturer uses these additional freeze frames, they will be stored under conditions defined by the manufacturer, and contain data specified by the manufacturer.

4.2.2 MESSAGE DATA BYTES—(See Figure 5.)

	Data Bytes (Hex)						
	#1	#2	#3	#4	#5	#6	#7
Request Powertrain Freeze Frame Data							
Request Powertrain Freeze Frame Data	02	PID	frame no.				
Report Powertrain Freeze Frame Data (only valid if Mode $02 PID $02 DTC is not $00 00)							
Report Powertrain Freeze Frame Data	42	PID	frame no.	data A	data B (opt)	data C (opt)	data D (opt)

FIGURE 5—MESSAGE DATA BYTES

4.3 PIDs for Modes $01 and $02—(See Figure 6.)

Modes *		PID (Hex)	Description	Min ($00) or ($0000)	Max ($FF) or ($FFFF)	SI (Metric) Scaling/bit and display	English scaling/bit and display
$01	$02						
X	X	00	PIDs supported ($01 - $20): Module responds with a message that contains 4 bytes of bit-encoded information, each bit indicating support or non-support of a PID where: 0 = PID not supported by this module 1 = PID supported by this module		Byte bit PID Data A 7 $01 Data A 6 $02 . . . Data B 7 $09 . . . Data D 0 $20		
X		01	Data A - Number of emission-related powertrain trouble codes and MIL status: bits 0-6: Number of codes stored in this module bit 7: 0 = MIL not commanded ON by this module 1 = MIL commanded ON by this module Data B and Data C - Each bit indicates support or non-support of an on-board diagnostic evaluation: Data B covers continuous monitoring tests Data C covers tests run at least once per trip where: 0 = test not supported by this module 1 = test supported by this module Data D - Each bit indicates status of on-board diagnostic evaluation for this module, corresponding to tests included in Data C: 0 = test complete, or not applicable 1 = test not complete		Data B: bit Evaluation supported 0 Misfire monitoring 1 Fuel system monitoring 2 Comprehensive component monitoring 3 reserved (report as 0) 4 reserved (report as 0) 5 reserved (report as 0) 6 reserved (report as 0) 7 reserved (report as 0) Data C and Data D: bit Evaluation supported / status 0 Catalyst monitoring 1 Heated catalyst monitoring 2 Evaporative system monitoring 3 Secondary air system monitoring 4 A/C system refrigerant monitoring 5 Oxygen sensor monitoring 6 Oxygen sensor heater monitoring 7 EGR system monitoring	

(R) FIGURE 6—PIDS FOR MODES $01 AND $02

Modes *		PID (Hex)	Description	Min ($00) or ($0000)		Max ($FF) or ($FFFF)		SI (Metric) Scaling/bit and display	English scaling/bit and display
$01	$02								
	X	02	Trouble code that caused required freeze frame data storage (2 byte value - $0000 indicates no freeze frame data)	00	00	09	99	Pxxxx	
X	X	03	Data A: Fuel system 1 status Data B: Fuel system 2 status ($00 if not used) For each data byte, no more than one bit at a time can be set to a 1 to indicate the status of that bank. where: bit 0 = Open loop - has not yet satisfied conditions to go closed loop. bit 1 = Closed loop - using oxygen sensor(s) as feedback for fuel control bit 2 = Open loop due to driving conditions (power enrichment, deceleration enleanment) bit 3 = Open loop due to detected system fault bit 4 = Closed loop, but fault with at least one oxygen sensor - may be using single oxygen sensor for fuel control bits 5-7 = reserved (report as 0)						
X	X	04	Calculated load value	0%		100%		100/255% xxx.x%	
X	X	05	Engine coolant temperature	-40°C		215°C		1°C.with -40°C offset xxx°C	xxx°F
X	X	06	Short term fuel trim - Bank 1 (use if only 1 fuel trim value)	-100.00% (lean)		99.22% (rich)		100/128% (0% at 128) xxx.x%	
X	X	07	Long term fuel trim - Bank 1	•		•		•	
X	X	08	Short term fuel trim - Bank 2	•		•		•	
X	X	09	Long term fuel trim - Bank 2	•		•		•	
X	X	0A	Fuel pressure (gage)	0 kPaG		765 kPaG		3 kPaG xxx kPaG	xx.x psig

(R) FIGURE 6—PIDS FOR MODES $01 AND $02 (CONTINUED)

Modes *		PID (Hex)	Description	Min ($00) or ($0000)	Max ($FF) or ($FFFF)	SI (Metric) Scaling/bit and display	English scaling/bit and display
$01	$02						
X	X	0B	Intake manifold absolute pressure	0 kPaA	255 kPaA	1 kPaA xxx kPaA	xx.x In. Hg
X	X	0C	Engine RPM (2 byte value - high byte/low byte)	0 r/min	16,383.75 r/min	1/4 r/min xxxxx r/min	
X	X	0D	Vehicle speed	0 km/h	255 km/h	1 km/h xxx km/h	xxx MPH
X		0E	Ignition timing advance for #1 cylinder (not including mechanical advance)	-64°	+63.5°	1/2° with 0° at 128 xx.x°	
X		0F	Intake air temperature	-40°C	215°C	1°C with -40°C offset xxx°C	xxx F
X		10	Air flow rate from MAF sensor (2 byte value - high byte/low byte)	0 gm/sec	655.35 gm/sec	.01 gm/sec xxx.xx gm/sec	xxxx.x lb/min
X		11	Absolute throttle position sensor	0%	100%	100/255% xxx.x%	
X		12	Commanded secondary air status (if supported, one, and only one bit at a time can be set to a 1) bit 0 1 = upstream of first catalytic converter bit 1 1 = downstream of first catalytic converter inlet bit 2 1 = atmosphere / off bits 3 - 7 = reserved (report as 0)				

FIGURE 6—PIDS FOR MODES $01 AND $02 (CONTINUED)

Modes *		PID (Hex)	Description	Min ($00) or ($0000)	Max ($FF) or ($FFFF)	SI (Metric) Scaling/bit and display	English scaling/bit and display
$01	$02						
X		13	Location of oxygen sensors, where sensor 1 is closest to the engine. Each bit indicates the presence or absence of an oxygen sensor at the following location: bit Sensor location Alternative sensor location 0 Bank 1 - Sensor 1 Bank 1 - Sensor 1 1 Bank 1 - Sensor 2 Bank 1 - Sensor 2 2 Bank 1 - Sensor 3 Bank 2 - Sensor 1 3 Bank 1 - Sensor 4 Bank 2 - Sensor 2 4 Bank 2 - Sensor 1 Bank 3 - Sensor 1 5 Bank 2 - Sensor 2 Bank 3 - Sensor 2 6 Bank 2 - Sensor 3 Bank 4 - Sensor 1 7 Bank 2 - Sensor 4 Bank 4 - Sensor 2 where: 1 = sensor present at that location 0 = sensor not present at that location				
X		14 15 16 17 18 19 1A 1B	Bank 1 - Sensor 1 Bank 1 - Sensor 2 Bank 1 - Sensor 3 Bank 1 - Sensor 4 Bank 2 - Sensor 1 Bank 2 - Sensor 2 Bank 2 - Sensor 3 Bank 2 - Sensor 4 for each sensor: Data A - Oxygen sensor output voltage Data B - short term fuel trim associated with this sensor ($FF if this sensor is not used in the calculation)	0 volt -100.00% (lean)	1.275 volt 99.22% (rich)	This scaling assumes a nominal 1 volt full scale oxygen sensor; any sensor with a different full scale value should be normalized to provide nominal full scale at $C8 (200 decimal). .005 volt x.xxx volt 100/128% (0% at 128) xxx.x%	

(R) FIGURE 6—PIDS FOR MODES $01 AND $02 (CONTINUED)

Modes *		PID (Hex)	Description	Min ($00) or ($0000)	Max ($FF) or ($FFFF)	SI (Metric) Scaling/bit and display	English scaling/bit and display
$01	$02						
#		1C	OBD requirements to which vehicle is designed, where: 01 - OBD II (California ARB) 02 - OBD (Federal EPA) 03 - OBD and OBD II 04 - OBD I 05 - Not intended to meet any OBD requirements				
		1D-1F	Unused - reserved for future expansion				
X		20	PIDs supported ($21 - $40):			Byte bit PID Data A 7 $21 Data A 6 $22 ... Data B 7 $29 ... Data D 0 $40	
		21-3F	Reserved - to be specified in J2190, if needed				
X		40	PIDs supported ($41 - $60):				
X		41-FF	Reserved for future expansion				

* NOTE: An "X" in the column under Mode $01 or $02 indicates that this value is included in OBD II regulations to be supported for this mode. Refer to the latest OBD II regulations to determine if each value is required to be supported on a given vehicle, or only required if available.

\# Although only vehicles meeting California ARB OBD II and Federal OBD regulations are required to support this document, manufacturers of other vehicles may choose to support this request for the convenience of service technicians.

(R) FIGURE 6—PIDS FOR MODES $01 AND $02 (CONTINUED)

4.4 Mode $03—Request Emission-Related Powertrain Diagnostic Trouble Codes

4.4.1 FUNCTIONAL DESCRIPTION—The purpose of this mode is to enable the off-board test device to obtain stored emission-related powertrain trouble codes. This should be a two step process for the test equipment.

a. Step 1—Send a Mode $01, PID $01 request to get the number of stored emission-related powertrain trouble codes from all modules that have this available. Each on-board module that has stored codes will respond with a message that includes the number of stored codes which that module can report. If a module capable of storing powertrain codes does not have stored codes, then that module shall respond with a message indicating zero codes are stored.

b. Step 2—Send a Mode $03 request for all stored emission-related powertrain codes. Each module that has codes stored will respond with one or more messages, each containing up to 3 codes. If no codes are stored in the module, then the module will not respond to this request.

If additional trouble codes are set between the time that the number of codes are reported by a module, and the stored codes are reported by a module, then the number of codes reported could exceed the number expected by the tool. In this case, the tool should repeat this cycle until the number of codes reported equals the number expected based on the Mode 1 response.

Diagnostic trouble codes are transmitted in two bytes of information for each code. The first two bits (high order) of the first byte for each code will be zeroes to indicate a powertrain code (refer to SAE J2012 for additional interpretation of this structure). The second two bits will indicate the first digit of the diagnostic code (0 through 3). The second nibble of the first byte and the entire second byte are the next three digits of the actual code reported as Binary Coded Decimal (BCD). A powertrain trouble code transmitted as $0143 should be displayed as P0143. (See Figure 7.)

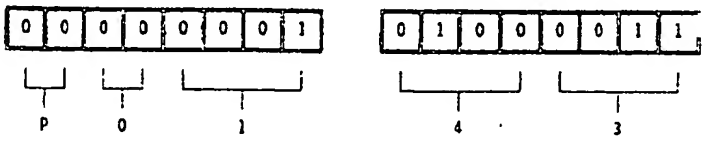

FIGURE 7—DIAGNOSTIC TROUBLE CODE ENCODING EXAMPLE

If less than 3 trouble codes are reported, the response messages used to report diagnostic trouble codes should be padded with $00 to fill 7 data bytes. This maintains the required fixed message length for all messages.

4.4.2 MESSAGE DATA BYTES—(See Figure 8.)

	Data Bytes (Hex)						
	#1	#2	#3	#4	#5	#6	#7
Request number of codes from all modules							
Request number of Powertrain DTC	01	01					
Report number of codes (each module)							
Report number of stored powertrain DTC	41	01	# DTC & MIL	Eval. Supp. #1	Eval. Supp. #2	Eval. Status	
Request codes from all modules							
Request powertrain DTC	03						
Report codes (each module)							
Report powertrain DTC	43	Code #1		Code #2 or 00 00		Code #3 or 00 00	

NOTE—Refer to SAE J2012 for encoding method for trouble codes.

FIGURE 8—MESSAGE DATA BYTES

4.4.3 POWERTRAIN DIAGNOSTIC TROUBLE CODE EXAMPLE (ASSUME 10.4 Kbps)—(See Figure 9.)

	Header Bytes (Hex)			Data Bytes (Hex)						
	P/T	Tgt	Src	#1	#2	#3	#4	#5	#6	#7
Request Powertrain DTC										
Request number of Powertrain DTC	68	6A	F1	01	01					
Report Number of Powertrain DTC										
Module 06 has 6 stored DTC	48	6B	06	41	01	06	00	00	00	
Module C3 has 1 stored DTC	48	6B	C3	41	01	01	00	00	00	
Module 2B has 0 stored DTC	48	6B	2B	41	01	00	00	00	00	
Module 3E has 2 stored DTC and MIL ON	48	6B	3E	41	01	82	00	00	00	
Request All Stored Powertrain DTC										
Request powertrain DTC	68	6A	F1	03						
Report All Stored Powertrain DTC										
Module 06 send codes P0143, P0196, & P0234	48	6B	06	43	Code #1		Code #2		Code #3	
					01	43	01	96	02	34
Module C3 send code P0443	48	6B	C3	43	Code #1		00	00	00	00
					04	43				
Module 06 send codes P0357, P0531, & P0661	48	6B	06	43	Code #4		Code #5		Code #6	
					03	57	05	31	06	61
Module 3E send codes P0112 & P0445	48	6B	3E	43	Code #1		Code #2		00	00
					01	12	04	45		

FIGURE 9—POWERTRAIN DIAGNOSTIC TROUBLE CODE EXAMPLE (ASSUME 10.4 Kbps)

4.5 Mode $04—Clear/Reset Emission-Related Diagnostic Information

4.5.1 FUNCTIONAL DESCRIPTION—The purpose of this mode is to provide a means for the external test device to command on-board modules to clear all emission-related diagnostic information. This includes:

a. Clear number of diagnostic trouble codes (Mode $01, PID $01)
b. Clear diagnostic trouble codes (Mode $03)
c. Clear trouble code for freeze frame data (Mode $01, PID $02)
d. Clear freeze frame data (Mode $02)
e. Clear oxygen sensor test data (Mode $05)
f. Reset status of system monitoring tests (Mode $01, PID $01)
g. Clear on-board monitoring test results (Mode $06 and $07)

Other manufacturer specific "clearing/resetting" actions may also occur in response to this request.

(R) For safety and/or technical design reasons, some modules may not respond to this test mode under all conditions. All modules must respond to this test mode request with the ignition ON and with the engine not running. Modules that cannot perform this operation under other conditions, such as with the engine running, will ignore the request.

4.5.2 MESSAGE DATA BYTES—(See Figure 10.)

4.6 Mode $05—Request Oxygen Sensor Monitoring Test Results

4.6.1 FUNCTIONAL DESCRIPTION—The purpose of this mode is to allow access to the on-board oxygen sensor monitoring test results as required in OBD II regulations. Use of this mode is optional, depending on the method used by the vehicle manufacturer to comply with the requirement for oxygen sensor monitoring.

	Data Bytes (Hex)						
	#1	#2	#3	#4	#5	#6	#7
Request to Clear/Reset Emission-Related Diagnostic Information							
Clear Powertrain DTC	04						
Report when Emission-Related Diagnostic Information is Reset							
Powertrain DTC cleared	44						

FIGURE 10—MESSAGE DATA BYTES

The on-board module will respond to this message by transmitting the reThe request for test results includes a Test ID value that indicates the information requested. Test value definitions, scaling information, and display formats are included in this document.

Many methods may be used by different manufacturers to comply with this requirement. If data values are to be reported using these messages that are different from those predefined in this document, ranges of test values have been assigned that can be used that have standard units of measure. The tool can convert these values and display them in the proper units.

quested test data last determined by the system.

	Data Bytes (Hex)						
	#1	#2	#3	#4	#5	#6	#7
Request Oxygen Sensor Test Results							
Request Oxygen Sensor Test Results	05	Test ID	02S #				
Report Oxygen Sensor Test ID Support - Optional (Test IDs $00, $20, $40, $60, $80, $A0, $C0, $E0)							
Report Oxygen Sensor Test ID Support	45	Test ID	02S #	Support for the next 32 test IDs following the requested ID is indicated in data bytes #4 through #7			
Report Oxygen Sensor Test Results. (All Test IDs That Don't Indicate Test ID Support)							
Report Oxygen Sensor Test Results	45	Test ID	02S #	test value	min limit (opt)*	max limit (opt)*	

* NOTE—Report limits if value is a test result—not required for test constants, such as ID $01 to $04.

(R) FIGURE 11—MESSAGE DATA BYTES

The operation of this diagnostic mode in the on-board module is different from Mode $01. Mode $01 reports data value(s) that are stored internally at a single, or multiple contiguous, locations in memory. Mode $05 can report data values that are stored in non-contiguous memory locations. Test results will be stored in RAM, and test limits, if the value is a calculated value, would normally be stored in ROM. Therefore, the on-board software has additional requirements to respond to this request than it does for Mode $01 requests.

(R) Not all test values are applicable or supported by all vehicles. An optional feature of this test mode is for the on-board module to indicate which test IDs are supported. Test ID $00 is a bit-encoded value that indicates support for test IDs from $01 to $20. Test ID $20 indicates support for test IDs $21 through $40, etc. This is the same concept as used for PID support in test modes $01 and $02. If Test ID $00 is not supported, then the module does not use this feature to indicate test ID support.

4.6.2 MESSAGE DATA BYTES—(See Figures 11, 12, and 13.)

Results of latest mandated on-board oxygen sensor monitoring test.

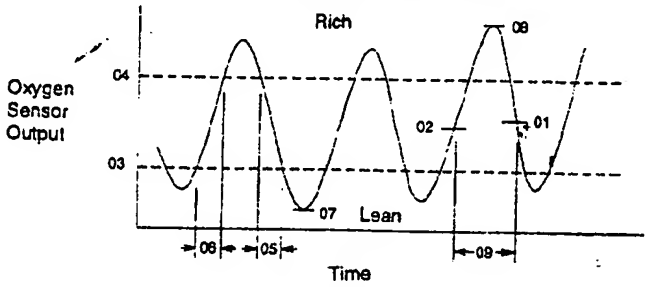

FIGURE 12—TEST ID VALUE EXAMPLE

Data Byte	Description
2	Which Test ID: $00 - Test ID's supported - optional ($01 to $20) $01 - Rich to lean sensor threshold voltage (constant) $02 - Lean to rich sensor threshold voltage (constant) $03 - Low sensor voltage for switch time calculation (constant) $04 - High sensor voltage for switch time calculation (constant) $05 - Rich to lean sensor switch time (calculated) $06 - Lean to rich sensor switch time (calculated) $07 - Minimum sensor voltage for test cycle (calculated) $08 - Maximum sensor voltage for test cycle (calculated) $09 - Time between sensor transitions (calculated) $0A-$1F - reserved $20 - Test ID's supported - optional ($21 to $40) $21-$2F - values with units of time less than 1.02 seconds $30-$3F - values with units of time less than 10.2 seconds $40 - Test ID's supported - optional ($41 to $60) $41-$4F - values with units of voltage less than 1.275 volts $50-$5F - values with units of voltage less than 12.75 volts $60 - Test ID's supported - optional ($61 to $80) $61-$6F - values with units of Hertz less than 25.5 Hz $70-$7F - values with units of counts less than 255 counts $80 - Test ID's supported - optional ($81 to $A0) $81-$9F - manufacturer specific values / units $A0 - Test ID's supported - optional ($A1 to $C0) $A1-$BF - manufacturer specific values / units $C0 - Test ID's supported - optional ($C1 to $E0) $C1-$DF - manufacturer specific values / units $E0 - Test ID's supported - optional ($E1 to $FF) $E1-$FF - manufacturer specific values / units
3	Oxygen sensor location (one, and only one bit can be set to a 1): bit — Sensor location — Alternative sensor location 0 — Bank 1 - Sensor 1 — Bank 1 - Sensor 1 1 — Bank 1 - Sensor 2 — Bank 1 - Sensor 2 2 — Bank 1 - Sensor 3 — Bank 2 - Sensor 1 3 — Bank 1 - Sensor 4 — Bank 2 - Sensor 2 4 — Bank 2 - Sensor 1 — Bank 3 - Sensor 1 5 — Bank 2 - Sensor 2 — Bank 3 - Sensor 2 6 — Bank 2 - Sensor 3 — Bank 4 - Sensor 1 7 — Bank 2 - Sensor 4 — Bank 4 - Sensor 2 where: 1 = sensor present at that location 0 = sensor not present at that location

(R) FIGURE 13—MESSAGE DATA BYTE DESCRIPTION

Data Byte	Description
	The following 4 bytes define data bytes for Test IDs that indicate support of other Test IDs - optional (Modes $00, $20, $40, $60, $80, $A0, $C0, and $E0)
4	Support for Test ID, where 1=support, 0=non-support: bit 7 - support for Test ID $01 bit 6 - support for Test ID $02 . . bit 0 - support for Test ID $08
5	Support for Test ID, where 1=support, 0=non-support: bit 7 - support for Test ID $09 bit 6 - support for Test ID $0A . . bit 0 - support for Test ID $10
6	Support for Test ID, where 1=support, 0=non-support: bit 7 - support for Test ID $11 bit 6 - support for Test ID $12 . . bit 0 - support for Test ID $18
7	Support for Test ID, where 1=support, 0=non-support: bit 7 - support for Test ID $19 bit 6 - support for Test ID $1A . . bit 0 - support for Test ID $20

(R) FIGURE 13—MESSAGE DATA BYTE DESCRIPTION (CONTINUED)

Data Byte	Description
	The following 3 bytes define data bytes for Test IDs that report data values
4	Test ID: — Min ($00): — Max ($FF): — Scaling/bit Test ID $01 — 0 volt — 1.275 v. — .005 v. Test ID $02 — 0 volt — 1.275 v. — .005 v. Test ID $03 — 0 volt — 1.275 v. — .005 v. Test ID $04 — 0 volt — 1.275 v. — .005 v. Test ID $05 — 0 sec. — 1.02 sec. — .004 sec. Test ID $06 — 0 sec. — 1.02 sec. — .004 sec. Test ID $07 — 0 volt — 1.275 v. — .005 v. Test ID $08 — 0 volt — 1.275 v. — .005 v. Test ID $09 — 0 sec. — 10.2 sec. — .04 sec. Test ID $21-$2F — 0 sec. — 1.02 sec. — .004 sec. Test ID $30-$3F — 0 sec. — 10.2 sec. — .04 sec. Test ID $41-$4F — 0 volt — 1.275 v. — .005 volt Test ID $50-$5F — 0 volt — 12.75 v. — .05 volt Test ID $61-$6F — 0 Hz — 25.5 Hz — .1 Hz Test ID $70-$7F — 0 counts — 255 counts — 1 count
5	Minimum test limit (only for calculated test result) see Data Byte #4 for minimum value, maximum value, and scaling
6	Maximum test limit (only for calculated test result) see Data Byte #4 for minimum value, maximum value, and scaling

NOTE— Current oxygen sensors are nominally 1 V full scale. If an oxygen sensor is used with a different nominal output, the output voltage should be normalized to 1 V. Full scale should be reported as $C8 (decimal 200), which allows for reporting an overvoltage condition.

(R) FIGURE 13—MESSAGE DATA BYTE DESCRIPTION (CONTINUED)

(R) **4.7 Mode $06—Request On-Board Monitoring Test Results for Non-Continuously Monitored Systems**

(R) 4.7.1 FUNCTIONAL DESCRIPTION—The purpose of this test mode is to allow access to the results for on-board diagnostic monitoring tests of specific components/systems that are not continuously monitored. Examples are catalyst monitoring and the evaporative system monitoring.

The vehicle manufacturer is responsible to assign test IDs and component IDs for tests of different systems and components. Test results are requested by test ID. Only one test limit is included in a response message, but that limit could be either a minimum or a maximum limit. If both a minimum and maximum test limit are to be reported, then two response messages will be transmitted, in any order. The most significant bit of the "test limit type/component ID" byte will be used to indicate the test limit type.

This test mode can be used as an alternative to Mode $05 to report oxygen sensor test results.

(R) 4.7.2 MESSAGE DATA BYTES—(See Figure 14.)

	Data Bytes (Hex)						
	#1	#2	#3	#4	#5	#6	#7
Request Test Results							
Request Test Results	06	Test ID					
Report Test ID Support (Test IDs $00, $20, $40, $60, $80, $A0, $C0, $E0)							
Report Test ID Support	46	Test ID	FF	Support for the next 32 test IDs following the requested ID for any component is indicated in data bytes #4 through #7			
Report Test Results Multiple Responses may be Transmitted (Test IDs other than $00, $20, $40, $60, $80, $A0, $C0, $E0)							
Report Test Results	46	Test ID	Test Limit Type & Component ID	test value		test limit	
				MSB	LSB	MSB	LSB

(R) FIGURE 14—MESSAGE DATA BYTES

Data Byte	Description
2	Test ID: $C0 - Test ID's supported ($01 to $20) $01-$1F - values defined by manufacturer $20 - Test ID's supported ($21 to $40) $21-$3F - values defined by manufacturer $40 - Test ID's supported ($41 to $60) $41-$5F - values defined by manufacturer $60 - Test ID's supported ($61 to $80) $61-$7F - values defined by manufacturer $80 - Test ID's supported ($81 to $A0) $81-$9F - values defined by manufacturer $A0 - Test ID's supported ($A1 to $C0) $A1-$BF - values defined by manufacturer $C0 - Test ID's supported ($C1 to $E0) $C1-$DF - values defined by manufacturer $E0 - Test ID's supported ($E1 to $FF) $E1-$FF - values defined by manufacturer
3	bit 7: Most significant bit indicates type of test limit, where: 0 - test limit is maximum value - test fails if test value is greater than this value 1 - test limit is minimum value - test fails if test value is less than this value If the test result should be within a range of values, two messages will be returned, one with the maximum value and one with the minimum value bit 6 - bit 0: Component ID - manufacturer defined - necessary when multiple components or systems are present on the vehicle and have the same definition of test ID

(R) FIGURE 14—MESSAGE DATA BYTES (CONTINUED)

Data Byte	Description
	The following 4 bytes define data bytes for Test IDs that indicate support of other Test IDs (Modes $00, $20, $40, $60, $80, $A0, $C0, and $E0)
4	Support for Test ID, where 1=support, 0=non-support: bit 7 - support for Test ID $01 bit 6 - support for Test ID $02 . . bit 0 - support for Test ID $08
5	Support for Test ID, where 1=support, 0=non-support: bit 7 - support for Test ID $09 bit 6 - support for Test ID $0A . . bit 0 - support for Test ID $10
6	Support for Test ID, where 1=support, 0=non-support: bit 7 - support for Test ID $11 bit 5 - support for Test ID $12 . . bit 0 - support for Test ID $18
7	Support for Test ID, where 1=support, 0=non-support: bit 7 - support for Test ID $19 bit 6 - support for Test ID $1A . . bit 0 - support for Test ID $20
	The following 4 bytes define data bytes for Test IDs that report data values (multiple response messages will be received if there are multiple components that support the same test ID and $FF is included as data byte #3 in the request message)
4-5	Test result (two byte value) - this value should be less than or equal to the test limit if most significant bit of data byte #3 is '0', and should be greater than or equal to the test limit if most significant bit of data byte #3 is '1'
6-7	Test limit (two byte value)

(R) FIGURE 14—MESSAGE DATA BYTES (CONTINUED)

(R) 4.7.3 Message Example—(See Figure 15.)

(R) **4.8 Mode $07—Request On-Board Monitoring Test Results for Continuously Monitored Systems**

(R) 4.8.1 FUNCTIONAL DESCRIPTION—The purpose of this mode is to enable the off-board test device to obtain test results for emission-related powertrain components/systems that are continuously monitored during normal driving conditions. The intended use of this data is to assist the service technician after a vehicle repair, and after clearing diagnostic information, by reporting test results after a single driving cycle. If the test failed during the driving cycle, the DTC associated with that test will be reported. Test results reported by this mode do not necessarily indicate a faulty component/system. If test results indicate a failure after additional driving, then the MIL will be illuminated and a DTC will be set and reported with Mode $03, indicating a faulty component/system.

Test results for these components/systems are reported in the same format as the diagnostic trouble codes in Test Mode $03— refer to the functional description for Mode $03.

If less than 3 DTC values are reported for failed tests, the response messages used to report the test results should be padded with $00 to fill 7 data bytes. This maintains the required fixed message length for all messages.

If there are no test failures to report, no response is required.

(R) 4.8.2 MESSAGE DATA BYTES—(See Figure 16.)

	Data Bytes (Hex)						
	#1	#2	#3	#4	#5	#6	#7
Determine Test ID Support							
Request Test ID Support - ID in Hex	06	00					
Report Support for Test IDs 06, 10, 1E and 20	46	00	FF	00000100 =04	00000001 =01	00000000 =00	00000101 =05
Request Test ID Support	06	20					
Report Support for Test ID 40	46	20	FF	00000000 =00	00000000 =00	00000000 =00	00000001 =01
Request Test ID Support	06	40					
Report Support for Test ID 60	46	40	FF	00000000 =00	00000000 =00	00000000 =00	00000001 =01
Request Test ID Support	06	60					
Report Support for Test ID 80	46	60	FF	00000000 =00	00000000 =00	00000000 =00	00000001 =01
Request Test ID Support	06	80					
Report Support for Test ID A0	46	80	FF	00000000 =00	00000000 =00	00000000 =00	00000001 =01
Request Test ID Support	06	A0					
Report Support for Test ID A1 - no additional test IDs supported	46	A0	FF	10000000 =10	00000000 =00	00000000 =00	00000000 =00

(R) FIGURE 15—MESSAGE EXAMPLE

	Data Bytes (Hex)						
	#1	#2	#3	#4	#5	#6	#7
Following messages indicate test results for component 01 greater than the minimum							
Request Results for Test ID 06	06	06					
Report Results for component 01 - test value exceeds minimum - passed	46	06	81	test value		minimum test limit	
				32	C4	16	00
Following messages indicate test results greater than the maximum for component ID 01 and less than the maximum for component 02							
Request Results for Test ID 10	06	10					
Report Results for component 01 - test value greater than maximum - failed	46	10	01	test value		maximum test limit	
				92	36	7F	FF
Report Results for component 02 - test value less than maximum - passed	46	10	02	test value		maximum test limit	
				06	51	58	43
Following messages indicate test results for component 31 between the minimum and maximum limits							
Request Results for Test ID A1	06	A1					
Report Results for component 31 - test value greater than minimum - passed	46	A1	81	test value		minimum test limit	
				35	95	14	00
Report Results for component 31 - test value less than maximum - passed	46	A1	31	test value		maximum test limit	
				35	95	66	53

(R) FIGURE 15—MESSAGE EXAMPLE (CONTINUED)

	Data Bytes (Hex)						
	#1	#2	#3	#4	#5	#6	#7
Request test results for continuously monitored systems							
Request test results	07						
Report test results for continuously monitored systems							
Report test results	47	Code #1 or 00 00		Code #2 or 00 00		Code #3 or 00 00	

FIGURE 16—MESSAGE DATA BYTES